APPLIANCE TO PREVENT LOCKED FINGERS DURING SLEEP AND FOR EXERCISING GRIP

Background Of The Invention

Some persons, particularly among those who are senior citizens, are afflicted with a chronic condition whose medical term is stenosing tenosynovitis, sometimes referred to as "trigger finger." When this affects the fingers of the human hand the symptoms include an inability to unbend one or more of the fingers (open the hand) from a flexed or clenched condition (as for a closed fist). The fingers of the hand are actuated by the motion of attached tendons that are each enclosed in a sheath. Stenosis is the constriction of a passage, such as a duct or sheath, and tenosynovitis is inflamation of a tendon. The stenosis of the tendon may be the result of an inflamation of it, as well. While the cause of these conditions is not well understood, the result is that a tendon can "get stuck" in its sheath. When tension applied via that tendon was how a finger became bent, then that finger is also "stuck" and cannot easily be straightened, especially when it has been fully, or almost fully, flexed (bent). A fully retracted and stuck tendon enjoys a mechanical advantage over its counterpart that straightens the finger, which is why the finger appears locked. There is often pain associated with this condition, and treatments include local injection of various drugs and even surgery to slit the sheath. Despite such interventions the condition often recurs.

This locking up of fingers is frequently avoidable during waking hours by consciously taking care to not manipulate the fingers of the hand in ways that will cause them to lock up. That is, by limiting the degree of flexure. While this may be a minor aggravation and represents some loss of dexterity, it is often manageable and acceptable as simply part of the price for growing old. But in some cases the victim clenches his fists during sleep, with the result that upon waking he or she must undergo a sometimes painful straightening process, made much worse if fingers on both hands are afflicted. If only one hand is afflicted, then the other hand can be used to pry the afflicted fingers open, after which they are again usable if not inadvertently allowed to again lock up. But if most of the fingers on both hands are afflicted, then the sufferer has a real problem, and must resort to desperate means to get his hands back in service:

the services of another person (which may not be available), hooking the fingertips over the edge of a table and pulling, pulling with the teeth (assuming one doesn't need to put them in, first ...) and so on. All in all, it is not a pleasant way to start the day, and this condition may in fact even be hazardous (or at the very least, quite inconvenient) under certain middle-of-the-night emergency situations where one needs the use of his hands to quickly open a window, climb out a window, deal with a door lock, open a closed door, or simply use the bathroom.

It would be desirable if there were a convenient and effective way of preventing this condition from resulting in locked fingers after sleep.

There are also individuals who need or desire to exercise the muscles of the hand, perhaps to maintain the use of their hands in face of declining functionality and as part of a physical therapy regimen, or to improve their grip for recreational purposes (e.g., rock climbers). There are many hand-held appliances known for such exercise, but most are not adjustable as to hand size and degree of strength required for use, and they generally not captive within the hand during use. It would be desirable if there were an inexpensive, durable, adjustable and captive hand exercise appliance. It would be especially desirable if it were also effective in preventing the condition of locked fingers during sleep.

Summary Of The Invention

A solution to the problem of fingers that lock up from fists clenched during sleep (the "trigger finger" condition) is to limit the degree of flexure (closure) that the fingers can experience. This may be done by affixing an object of compressible resilient material proximate the palm of the hand, so that as the fingers curve to become flexed they wrap around the object and the degree of flexure is limited by the gradual but increasing resistance of the object to compression. The involuntary flexure of the fingers during sleep still occurs, but it is limited by the resistance of the compressible resilient object so that it is less than the amount needed to produce locking. The compressible resilient object may be a soft rubber ball. To keep the ball or other compressible resilient object in place during sleep the person may wear a comfortable glove on the hand, and the compressible resilient object is removably affixed to the exterior of that portion of the glove that covers the palm of the hand. If the compressible resilient object has the shape of a ball, then the fingers will close around it in a natural and comfortable fashion, as if it were being gripped and squeezed on purpose. The manner of affixing the compressible resilient object may be

with pieces of hook and loop fastener (known under the trademark Velcro). The glove may be of thin stretchable material that is also breathable (e.g., leather with sewn-in elastic) but having finger sections substantially shortened by omitting the ends thereof (as if cut away). The glove/fastener/ball combination holds the ball in place without conscious effort by the wearer, even if the hand relaxes entirely during portions of sleep. The ball is thus in place if involuntary flexure occurs later. The same appliance can be used to deliberately perform hand exercises, if desired. Different degrees of difficulty (resistance to squeezing) can be obtained by removing one compressible resilient object (which may be a rubber or plastic ball) and replacing it with another one having a different degree of resistance to compression. And for either use, the size of the compressible resilient object or diameter of the ball can be chosen to fit comfortably within the partially flexed fingers of the hand. And also for either use, the compressible resilient object or ball is readily removable. A ball that has been removed makes it easier to put on the glove (and the ball is then subsequently attached), and a detachable ball makes response to other tasks (answering the phone, opening a door) easier by allowing quick and easy removal of the ball without bothering to take off the glove. In an alternate embodiment elastic loops attached to a soft rubber ball engage the center fingers and the back of the palm to hold the ball in place, without the use of a glove. The attachment of the elastic loops to the compressible resilient object may either be removable, as with hook and loop fasteners, or be permanent.

Brief Description Of The Drawings

Figure 1 is a perspective view from the side of a left human hand and an appliance for preventing locked fingers during sleep and for exercising grip, but with a ball portion detached from a glove portion worn on the hand;

Figure 2 is a perspective view from below of the left hand and appliance of Figure 1, with the ball portion in place and the hand gripping the ball;

Figure 3 is a perspective view from above of the hand and appliance of Figure 2; and

Figure 4 is a perspective view from above of an alternate embodiment wherein elastic loops hold the soft rubber ball in place, without the use of a glove.

Description Of A Preferred Embodiment

Refer now to Figure 1, wherein is shown a perspective view 1 of a left human hand 2 wearing a glove 3 and equipped to removably attach a rubber ball 4 such that the ball 4 can be comfortably gripped by the thumb 7 and other fingers (8-11) of the hand 2. We have shown a ball 4 in Figure 1 (as well as in Figures 2 and 3 to follow), but it will be understood that the ball 4 is merely a preferred instance of a compressible resilient object that the hand 2 is to grip. The compressible resilient object might instead have the shape of a cylinder, or be an oblate spheroid (egg shaped), for example.

The ball 4 is to be nestled and retained in the palm of the hand 2 when it is being gripped. While awake one can deliberately do this by so placing the ball and then flexing the fingers (8-11) and thumb 7. But for certain exercise situations (poor muscle control or impaired coordination), or for holding the ball in place during sleep, the ball needs to be made captive for it to remain retained. A preferred way to do this is with pieces of hook and loop faster (commonly known by the trademark Velcro). Accordingly, note region 6 on the glove 3, whereat is affixed a circular patch of the hook part of the hook and loop fastener. A corresponding portion 5 of loop material is affixed to the ball 4. These circular patches may be in range of about one to two inches in diameter, and preferably they are attached by a flexible adhesive, such as contact cement, silicone rubber, vinyl cement, etc. The hook portion 6 might also be sewn onto the palm of the glove 3.

In brief, then, to use the appliance one puts on the glove, and if the ball is not already attached, extends the fingers to expose the palm, and then mates the loop portion 5 on the ball 4 with the hook portion 6 on the glove 3. It will be noted that the ball 4 can also be readily removed to permit unfettered use of the hand without the need to also remove the glove. It will further be appreciated that, just as the glove might need to be sized to fit the hand, selection of compressible resilient objects (balls 4) of different sizes (or having different degrees of resistance to compression) might be desirable, and is facilitated by the removable attachment property described above.

We turn now to the ball 4, with the understanding that much of what we say about it pertains to grippable compressible resilient objects of other suitable shapes. First, for an adult male the ball 4 might be about two and one half inches in diameter, and be made of soft rubber. As for size, it needs to be small enough that it can be gripped (i.e., the fingers do actually wrap around it), but not so small that a thumb 7, little finger 11, or other finger, can become fully flexed by sliding off to the side of the ball (or other

shape). The ball 4 or other compressible resilient shape could also be made of a suitable plastic material. A tennis ball, while about the right size, is way too stiff for this application, and has found to be uncomfortable. Furthermore, it is possible that its fuzzy exterior is a detriment; it interferes with attaching the loop portion 5, and complicates the task of keeping the ball 4 clean. Instead, it is preferred that the ball 4 be of closed cell foam rubber, with a smooth exterior surface.

Next, consider the hardness and compressibility of the ball 4. It is, as rubber balls go, pretty soft. One closed cell foam rubber ball of two and one half inches in diameter that was found to be quite suitable measures from about two to three on the Shore A scale using a durometer from NEWAGE Industries, Jenkinstown, PA and conforming to ASTM 2040 and DIN 53505. Those values are for initial contact with the durometer case that does not seriously deform the ball (the penetrator is, of course, in full contact). As the ball is compressed by further motion from the case of the durometer, say, to somewhat less than half its diameter, the ball begins to exhibit less compliance and its effective hardness increases to around twenty on the Shore A scale. Measured another way, the two and one half inch ball was placed between two parallel surfaces and its deformation was measured with different amounts of applied force. With five pounds applied the thickness was reduced to about one and three quarters inches; with ten pounds, to about an inch and a quarter; with twenty pounds to about seven eights of an inch; and, with twenty-five pounds to about three quarters of an inch. Once the thickness of about three quarters of an inch is reached, very little additional compression is observed with increased force. It appears that these results (and also the durometer results) reflect the existence of a cellular structure within the ball. Initial compression encounters less resistance as the cells are deformed. However, once all the cells along the direction of an applied force are fully deformed the adjacent cell walls are in successive contact. The material then begins to behave as if it were a slab of rubber, and exhibits a greater degree of hardness and resistance to compression.

An adult male in good health with strong hands is able to compress this same ball to a thickness of about thirty percent of its original diameter of two and one half inches, or to about three quarters of an inch. Such extreme compression would most likely occur only during deliberate exercise, but not during sleep. During sleep it can be expected that compression caused by involuntary clenching of the hand is much less, say, to only about seventy percent of original thickness.

The ball 4 (or other compressible resilient object) is resilient, in that it immediately returns to its normal shape when compression is removed.

A brief note is in order about the disc shaped patch 5 of loop material. It may be circular, but since it is not being affixed to a flat surface it will exhibit ridges when forced to conform to a spherical surface. It may, therefore, be desirable to cut a few thin wedge shaped slices out of the patch 5 before affixing it to the ball 4. Sticky backed merchant hook and loop fastener material has been found suitable, and this may obviate the need for a separate adhesive. It will be appreciated, however, that there are other ways of affixing the disc shaped patch 5 to the ball, and that those include adhesives, as well as mechanical techniques such as staking it, clipping it, etc.

We turn now to the glove 3. It will be appreciated that there is no need to fabricate a special glove; the modifications described herein can be performed to a suitable merchant glove and the results will be entirely satisfactory. That said, there are nevertheless certain desirable attributes that the glove ought to have. Chief among these are that it must fit comfortably and somewhat snugly. The material ought to be slightly stretchy, and not trap moisture against the skin (i.e., be breathable). For these reasons a glove made of thin leather is preferred. Examples include goatskin, sheepskin and pigskin, in the range of about .015" to .025" thick. The glove may have various ventilation holes 12 therein, as well as an elastic wristband and an adjustable strap 13 across the back.

An example of a suitable merchant glove in commerce is a glove intended for use by golfers, manufactured of cabretta goatskin and sold by APPLE SPORTS Inc. of Ronkonkoma NY, 11779 under license from the Wilson Sporting Goods Company and as part of its "Ultra" line. Wilson Sorting Goods is located at 8700 W. Bryn Mawr Ave, Chicago, Il, 60631. It will, of course, be appreciated that there are many suitable gloves available, and that one of those may be used as a component, or, that an original glove could be constructed for this purpose.

The disc 6 of hook fastener material may be attached to the palm of the glove with a strong and flexible adhesive. such as contact cement or silicone rubber. Stitching it in place is also possible, although some versions of hook fastener material have rather stout plastic hooks, which may make sewing difficult. An alternative (whether sewn or not) is to make the disc 6 be the more fibrous loop material, and put the hook portion on the ball, instead. Especially in this case (owing to the stiffness of a patch of hook

material), the comment above about removing thin wedge shaped slices from the disc being attached to the ball is particularly appropriate.

The exact diameter of the discs 5 and 6 of the hook and loop fastener material is not particularly critical, although there are certain considerations leading to a useful maximum and minimum. If the diameter is too small, then the ball or other compressible resilient object may pivot unduly off to one side, and by not being in the proper place, allow a finger or thumb to lock up. Also. There may not be sufficient retentive force to keep it in place during use. On the other hand, if the diameter of the disc 6 on the palm of the glove is too large, then there may be excessive freedom of location in locating the ball 4 against the hand, and once again the ball 4 is not in the proper position. Also, if the disc 5 on the ball is too large, then a waste of material occurs, since owing to the curvature of the ball only a certain amount of the fastener 5 on the ball will come into contact with the fastener 6 on the palm when the hand is not fully curved (fingers extended), anyway. Diameters of about three quarters of an inch to about two inches have been found satisfactory, with a preference of one and three quarters of an inch for adults.

As shown in the figures, the finger tips and thumb tip of the glove 3 have been removed at about where the glove reaches the joint nearest the knuckle. While not absolutely necessary, it is nevertheless desirable for these reasons. First, it increases comfort, and removes the length of one's fingers as a factor in proper fit. Next, it facilitates the normal use of the hand after the ball 4 is temporarily detached to accomplish some intervening task that arises, without having to also remove the glove. Examples might be: finding and activating a light switch in the dark, working a zipper, unlocking a door, etc.

The glove 3 shown in Figure 1 includes a strap 13. Its location is better shown in Figure 3, but it will be appreciated now that such a strap helps keep the glove in place (a definite comfort issue) while allowing easy application and removal. It is preferred that the strap 13 use a hook and loop fastener, also.

Finally, it will be noted that we have shown only a left hand 2 and a left-handed glove 3 and ball 4 therefor. It will of course be appreciated that a right-handed version exists, and that either can be used in isolation, or that they may be both used together.

Now turn to Figure 2, which is a perspective view 17 from below of the left hand 2 and glove/ball (4/3) combination (appliance) of Figure 1. It shows the ball 4 attached to the glove 3, and the thumb 7 and various finger (8-11) gripping the ball 4, either for exercise, or involuntarily during sleep.

Figure 3 is a perspective view 18 from above, of the situation in Figure 2. Note the strap 13, whose underside has a region of loop fastener that bears against a region 14 of hook fastener affixed to the back of the glove. It will be appreciated that, in addition to its utility in helping to produce proper fit, the strap 13 provides an ideal location for a product identification logo. Finally, note also the regions 15 and 16 of elastic material included to increase the glove's ability to conform comfortably to the wearer's hand.

We turn now to a discussion of alternate embodiments, including the one shown in Figure 4. Figure 4 is a perspective view from above of a ball 4 or other compressible resilient object that has affixed to it two bands or loops 20 and 21 of elastic material. There is no glove used in this embodiment, resulting in a monetary cost savings, but perhaps at some intangible cost of less perceived comfort, and perhaps reduced durability. In any event, arrows 22 and 23 indicate the direction that a right hand (not shown) would approach this embodiment. All four fingers (but not the thumb) would pass in the direction of arrow 22 through the loop or band 21, which is sized to fit snugly around the widest part of the hand, between the knuckles of the four fingers and the knuckle of the thumb. The center two fingers continue on to pass through loop or band 20 of elastic material, which is sized to fit snugly over those center two fingers of the hand. The thumb extends around the outside of the band or loop 21, in the direction shown by arrow 23.

We have shown and described the situation for a right hand approaching the ball 4 from the right to the left. By turning the ball one hundred and eighty degrees, a left hand can approach from the left to the right; the same ball and loop combination works for either hand.

Loop or band 20 may be of three eighths inch wide elastic material, while loop or band 21 may be of elastic material that is one half inch wide. These widths are, of course, merely illustrative. The elastic material may be sewn into the loops 20 and 21 (such a seam is not shown), preferably at locations least likely to cause discomfort; the locations 24 and 25 of contacting the ball are preferred. It will also be appreciated that at the locations 24 and 25 the manner of affixing the loops or bands 20 and 21 to the ball may be either permanent or removable. That is, loops 20 and 21 can be permanently affixed to the ball with adhesive or mechanical means, or removably affixed with regions of hook and loop fastener material (not shown), as in the embodiment of Figures 1-3. The two loops 20 and 21 could also be

incorporated or replaced by a wound, woven or crossed webbing of elastic material that encloses the hand while providing attachment to the compressible resilient object.

Finally, it will be appreciated that hook and loop fastener material, while preferred, is not the only manner of removable attachment that is possible for the embodiments described herein. Other possibilities include snaps, latches, laces and buckles. These same methods of attachment, along with the use of a suitable adhesive, may also be used to attach the compressible resilient object when there is no intent to have it be removable.